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PROVISIONAL SPECIFICATION

Improvements in or relating to Thermionic Valve Circuits

We, THE GENERAL ELECTRIC COMPANY LIMITED, of Magnet House, Kingsway, London, W.C.2, a British Company, and ROY FRANK PRIVETT, of Research Laboratories of The General Electric Company Limited, Wembley, Middlesex, a British Subject, do hereby declare the nature of this invention to be as follows:—

The present invention relates to thermionic valve circuits.

More particularly the invention relates to thermionic valve circuits of the kind adapted to provide a load impedance in the output circuit of a first valve and to apply voltages developed across this load impedance to the input of a second valve.

Such circuits are commonly used in valve amplifying circuits between adjacent valves. The present invention is particularly, but not exclusively, concerned with high frequency amplifying circuits designed to have wide-band amplification characteristics, such as the intermediate frequency amplifying circuits used in television equipment.

One object of the present invention is to provide improvements in such thermionic valve circuits.

According to the present invention a thermionic valve circuit of the kind specified comprises in the anode circuit of the first valve a first parallel resonant circuit, resonant at a predetermined frequency, which is effectively directly-connected to a second parallel resonant circuit, also resonant substantially at said predetermined frequency, in the input circuit of the second valve, at least an appreciable part of the capacitive reactance of each of said reonant circuits being provided by inter-electrode capacities of the associated valves.

A resonant damping circuit tuned to the predetermined frequency or a resistive impedance may be connected across part at least of the first parallel resonant circuit. The connection between the first and second resonant circuits may be through a direct-current blocking condenser of negligible impedance over the band of frequencies concerned. One connection of the second resonant circuit may be made to an intermediate point on the inductive reactance portion of the first resonant circuit to provide auto-transformer matching between the capacitive reactances of the first and second resonant circuits.

One form of thermionic valve circuit of the kind specified and according to the present invention, will now be described, by way of example, in which the circuit is adapted for use in a wide-band high-frequency amplifying circuit.

The first and second valves are each high frequency pentodes, and have their cathode heaters and screen grids suitably connected to appropriate electric sources. A grid bias resistance, suitably by-passed, is connected between the cathode of each valve and the nearest point thereto on the chassis, this point being used as a single common earthing point for the particular stage of the amplifier.

The circuit according to the present invention consists of an inductance connected between the anode of the first valve and, through a high-frequency decoupling circuit, the positive terminal of a high tension supply. The decoupling circuit consists of a resistance in series with the inductance, and a by-pass condenser connected between the common point of the resistance and inductance and the common point on the chassis to which the cathode of the first valve is connected. A second inductance is connected between the control grid of the second valve and the common point on the chassis to which the cathode of the second valve is connected. This control grid is connected through a direct-current blocking condenser to a tapping on the inductance in the anode circuit of the first valve. A series resonant circuit consisting of an inductance, capacitance and resistance is connected between the tapping point on the anode inductance

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and the common chassis point to which the cathode of the first valve is connected.

The circuit is designed so that the amplification/frequency characteristic of the circuit is such as to provide wide band amplification about a predetermined frequency. The value of the anode inductance is chosen so that together with the inter-electrode capacity, and any other stray capacity to earth, between the anode and cathode of the valve it forms a parallel resonant circuit which is resonant at the predetermined frequency. The value of the second inductance is likewise chosen to form a parallel resonant circuit with the inter-electrode and stray capacities between the control grid and cathode of the second valve, which is also resonant at the predetermined frequency. The series resonant circuit is also arranged to be resonant at this predetermined frequency. The direct-current blocking condenser is arranged to have a value such that it has substantially negligible impedance over the band of frequencies to be amplified, so that the grid resonant circuit is effectively connected directly to the tapping of the anode inductance.

The operation of the circuit is such that it provides amplification over a wide frequency band, the resistance in the series resonant circuit being chosen so that the damping effect of the series resonant circuit at frequencies close to the predetermined frequency serves to smooth-out to an appreciable extent the peak which would otherwise occur in the amplification/frequency characteristic of the circuit at such frequencies. The tapping point on the anode inductance is adjusted to a position at which the capacitance of the anode resonant circuit is substantially matched to the capacitance of the grid resonant circuit through the autotransformer action of the tapped inductance. This matching of the capacitances is found to give optimum amplification gain.

The present invention is limited to circuits in which the inter-electrode capacities of the valve are appreciable relative to the total capacitive reactance necessary for the anode load. In such cases if a single physical parallel resonant circuit were provided in the anode circuit of the first valve, high-frequency currents would circulate between the physical resonant circuit and the capacitive reactance provided by the inter-electrode capacities between the grid and cathode of the second valve, part of the circulating path being through the chassis between the points to which the respective cathodes are connected, which points, due to the physical size of the valves, are normally an appreciable distance apart. Such circulating currents through the chassis are undesirable at high frequencies as they may provide stray coupling between stages, and if successive stages are each mounted on an individual chassis, efficient bonding between chassis is then necessary to avoid undesirable resistance losses. In circuits according to the present invention however, such circulating currents are appreciably reduced by the provision of the two inductances which are adapted to resonate with the inter-electrode capacities of the first and second valves repectively the inductance, and other components connected to the chassis, in each stage all being connected to the common point on the chassis associated with the stage. Further advantages of a circuit according to the present invention are that due to the common point connections to the chassis successive stages may be mounted on individual chassis with less difficulty and without incurring such heavy losses due to circulating currents, and the individual mounting permits of the ready replacement of a defective stage by a spare stage already tuned to the required frequency, such a replacement not necessitating the retuning of either of the adjacent stages.

It will be understood that the series resonant circuit may be replaced by an impedance which is a substantially pure resistance, although such damping means are not essential to the invention but only desirable for smoothing-out the amplification/frequency characteristic of the circuit. Such a damping circuit should be connected in the anode circuit of the first valve, as opposed to the grid circuit of the second valve, to avoid circulating currents caused by the flow of anode current through the damping circuit.

It may be stated that such circuits have been produced having a band width of approximately twenty five megacycles per second, with the resonant circuits resonant at approximately thirty four megacycles per second.

Dated this 29th day of November, 1948.

For the Applicants,
W. J. C. CHAPPLE,
Chartered Patent Agent.

COMPLETE SPECIFICATION

Improvements in or relating to Thermionic Valve Circuits

We, THE GENERAL ELECTRIC COMPANY LIMITED, of Magnet House, Kingsway, London, W.C.2, a British Company, and ROY FRANK PRIVETT, of Research Labora-

tories of The General Electric Company Limited, Wembley, Middlesex, a British Subject, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The present invention relates to thermionic valve circuits.

More particularly the invention relates to thermionic valve circuits of the kind adapted to apply voltages developed across a load impedance in the output circuit of a first valve to the input circuit of a second valve.

Such circuits are commonly used in valve amplifying circuits comprising two or more valves. The present invention is particularly, but not exclusively, concerned with high frequency amplifying circuits designed to have wide-band amplification characteristics, such as the intermediate frequency amplifying circuits used in television equipment.

One object of the present invention is to provide improvements in such thermionic valve circuits.

According to the present invention a thermionic valve circuit of the kind specified is mounted on a chassis and comprises in the anode circuit of the first valve a first parallel resonant circuit, resonant at a predetermined frequency, which is connected by an impedance which is low at said predetermined frequency to a second separate parallel resonant circuit, also resonant at said predetermined frequency, in the input circuit of the second valve, at least an appreciable part of the capacitative reactance of each of said resonant circuits being provided by inter-electrode capacities of the associated valves, and all the components in each stage of the circuit which are connected to the chassis being connected to a common point on the chassis associated with that stage.

By a stage of the circuit is meant one of the valves together with its input and output circuits and any other components associated solely with that valve.

A resonant damping circuit tuned to said predetermined frequency of a substantial resistive impedance may be connected across part at least of the first parallel resonant circuit. The connection between the first and second resonant circuits may be through a direct current blocking condenser of negligible impedance over the band of frequencies concerned. One connection of the second resonant circuit may be made to an intermediate point on the inductive reactance portion of the first resonant circuit to provide auto-transformer matching between the capacitative reactances of the first and second resonant circuits.

One form of thermionic valve circuit of the kind specified and according to the present invention, will now be described, by way of example, with reference to the accompanying diagrammatic drawing, which shows a circuit adapted for use in a wide-band high-frequency amplifying circuit.

Referring to the drawing, the first and second valves 1 and 2 respectively are each high frequency pentodes, and have their cathode heaters connected to appropriate electric sources and their suppressor grids connected to their cathodes in conventional manner. Grid bias resistances 3 and 4 bypassed for alternating currents by condensers 5 and 6 are respectively connected between the cathodes of valves 1 and 2 and the respective points 7 and 8 on the chassis which are nearest to the two cathodes, the points 7 and 8 being used as single common earthing points for the respective stages of the amplifier. The screen grids of the valves 1 and 2 are connected to the positive terminal 9 of a high tension supply, whose negative terminal 10 is earthed, through resistances 11 and 12 respectively, bypass condensers 13 and 14 being connected between the screen grids of the valves 1 and 2 and the common points 7 and 8 on the chassis respectively.

The input to the circuit is applied to the control grid circuit of the valve 1 via terminals 15, and the output circuit of the valve 1 includes an inductance 16 whose ends are respectively connected to the valve 1 and to one end of a resistance 17 whose other end is connected to the terminal 9. A bypass condenser 18 is connected between the junction of the inductance 16 and the resistance 17 and the common point 7 on the chassis, the resistance 17 and condenser 18 together forming a high frequency decoupling circuit.

A tapping 19 on the inductance 16 is connected via a direct current blocking condenser 20 to one end of an inductance 21 and to the control grid of the valve 2, the other end of the inductance 21 being connected to the common point 8 on the chassis. The condenser 20 is arranged to have a value such that it has substantially negligible impedance over the band of frequencies to be amplified, so that the inductance 21 is effectively directly connected to the tapping 19. A series resonant consisting of an inductance 22, a condenser 23, and a resistance 24 is connected between the tapping 19 and the common chassis point 7.

The circuit is designed so that the

amplification/frequency characteristic of the circuit is such as to provide wide band amplification about a predetermined frequency. The value of the inductance 16 is chosen so that together with the inter-electrode capacity and any other stray capacity to earth between the anode and cathode of the valve 1, represented collectively in the drawing by the capacity 25, it forms a parallel resonant circuit which is resonant at the predetermined frequency. The value of the inductance 21 is likewise chosen to form a parallel resonant circuit with the inter-electrode and stray capacities between the control grid and cathode of the valve 2, represented collectively in the drawing by the capacity 26, which is also resonant at the predetermined frequency. The series resonant circuit is also arranged to be resonant at this predetermined frequency, the resistance 24 in the series resonant circuit being chosen so that the damping effect of the series resonant circuit at frequencies close to the predetermined frequency serves to smooth out to an appreciable extent the peak which would otherwise occur in the amplification/frequency characteristic of the circuit at such frequencies. The tapping point 19 on the inductance 16 is adjusted to a position at which the capacity 25 of the anode resonant circuit of the valve is substantially matched to the capacity 26 of the grid resonant circuit of the valve 2 through the auto-transformer action of the tapped inductance 16. This matching of the capacities 25 and 26 is found to give optimum amplification gain.

As shown in the drawing, the output circuit of the valve 2 may be similar to that of the valve 1, particularly if the amplifier includes a further stage. As shown, the anode circuit of the valve 2 includes an inductance 27 having an output tapping 28, and a decoupling circuit consisting of a resistance 29 and a condenser 30. The parallel resonant circuit is completed by the effective inter-electrode and stray capacity 31 between the anode and cathode of the valve 2.

The present invention is limited to circuits in which the inter-electrode capacities of the valve are appreciable relative to the total capacitative reactance necessary for the anode load. In such cases if a single physical parallel resonant circuit were provided in the anode circuit of the first valve, high-frequency currents would circulate between the physical resonant circuit and the capacitative reactance provided by the inter-electrode capacities between the grid and cathode of the second valve, part of the circulating path being through the chassis between the points to which the respective cathodes are connected, which points, due to the physical size of the valves, are normally an appreciable distance apart. Such circulating currents through the chassis are undesirable at high frequencies as they may provide stray coupling between stages, and if successive stages are each mounted on an individual chassis, efficient bonding between chassis is then necessary to avoid undesirable resistance losses. In circuits according to the present invention however, such circulating currents are appreciably reduced by the provision of the two inductances which are adapted to resonate with the inter-electrode capacities of the first and second valves respectively, the inductance, and other components connected to the chassis, in each stage all being connected to the common point on the chassis associated with the stage. Further advantages of a circuit according to the present invention are that due to the common point connections to the chassis successive stages may be mounted on individual chassis with less difficulty and without incurring such heavy losses due to circulating currents, and the individual mounting permits of the ready replacement of a defective stage by a spare stage already tuned to the required frequency, such a replacement not necessitating the retuning of either of the adjacent stages.

It will be understood that the series resonant circuit may be replaced by an impedance which is a substantially pure resistance, although such damping means are not essential to the invention but only desirable for smoothing-out the amplification/frequency characteristic of the circuit. Such a damping circuit should be connected in the anode circuit of the first valve, as opposed to the grid circuit of the second valve, to avoid circulating currents caused by the flow of anode current through the damping circuit.

It may be stated that such circuits have been produced having a band width of approximately twentyfive megacycles per second, with the resonant circuits resonant at approximately thirtyfour megacycles per second.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A thermionic valve circuit of the kind specified mounted on a chassis, comprising in the anode circuit of the first valve a first parallel resonant circuit, resonant at a predetermined frequency, which is connected by an impedance which is low at said predetermined fre-

quency to a second separate parallel resonant circuit, also resonant at said predetermined frequency, in the input circuit of the second valve, at least an appreciable part of the capacitative reactance of each of said resonant circuits being provided by inter-electrode capacities of the associated valves, and all the components in each stage of the circuit which are connected to the chassis being connected to a common point on the chassis associated with that stage.

2. A thermionic valve circuit according to Claim 1, in which each stage of the circuit is mounted on a separate section of the chassis which is removable from the rest of the chassis.

3. A thermionic valve circuit according to either of the preceding Claims, in which a resonant damping circuit tuned to said predetermined frequency or a substantially resistive impedance is connected across part at least of the first parallel resonant circuit.

4. A thermionic valve circuit according to any one of the preceding Claims, in which one connection of the second resonant circuit is made to an intermediate point on the inductive reactance portion of the first resonant circuit to provide auto-transformer matching between the capacitative reactances of the first and second resonant circuits.

5. A thermionic valve circuit of the kind specified substantially as hereinbefore described and as shown in the accompanying diagrammatic drawing.

Dated the 11th day of November, 1949.
For the Applicants,
W. J. C. CHAPPLE,
Chartered Patent Agent.

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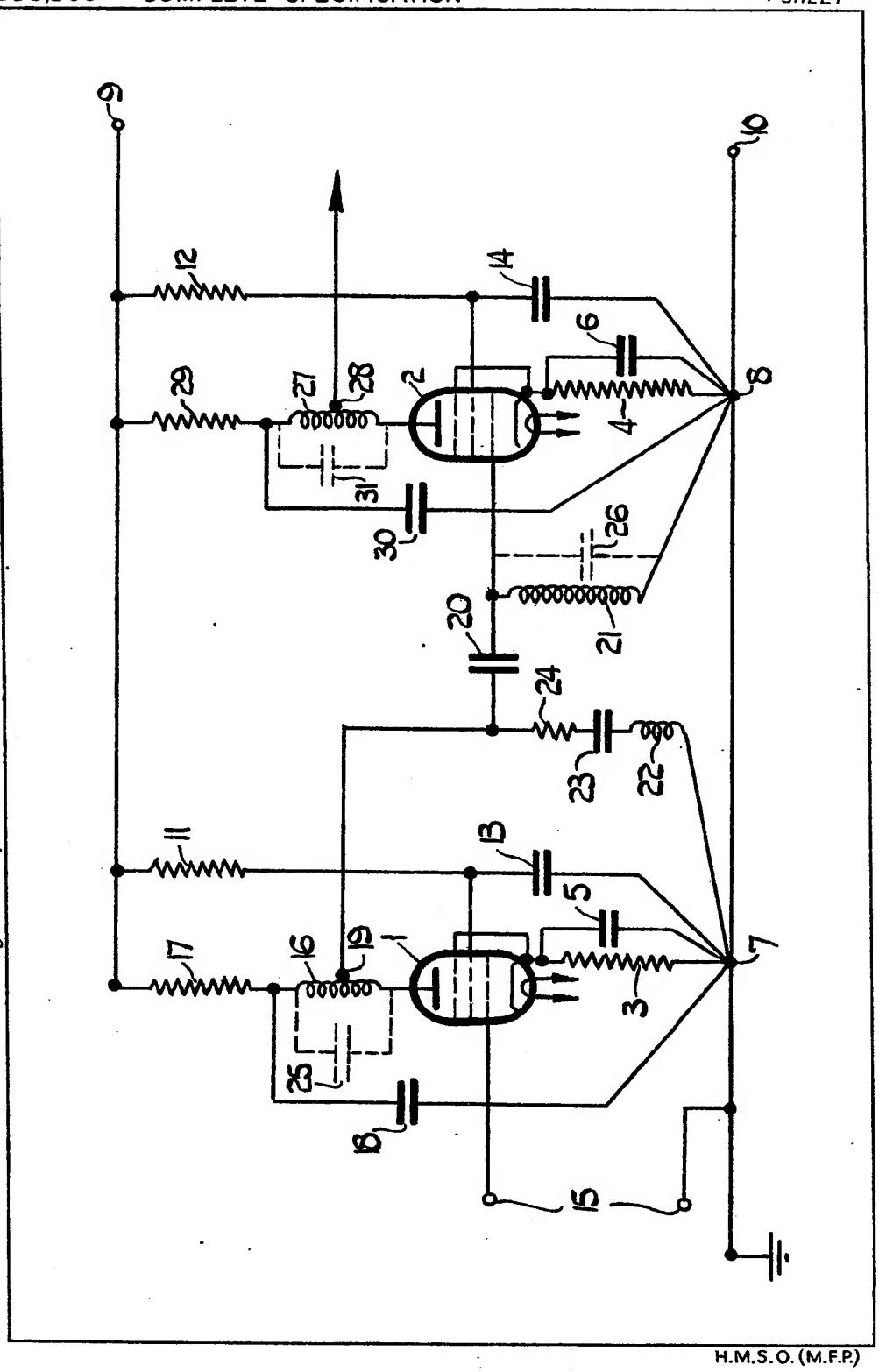

This Drawing is a reproduction of the Original on a reduced scale

H.M.S.O. (M.F.P.)